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Development study on PCM-TDMA satellite comm system
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DESCRIPTION

DIGITAL BROADCASTING APPARATUS

TECHNICAL FIELD

The present invention relates to a digital broadcasting apparatus, in particular to a digital broadcasting apparatus for digital terrestrial sound broadcasting.

BACKGROUND ART

As provisional systems of digital terrestrial television broadcasting and digital terrestrial sound broadcasting, broadcasting systems called the broadband ISDB-T system and narrow-band ISDB-T system have been proposed. These broadcasting systems are compatible with each other. At a bandwidth of about 429 kHz, which is obtained by dividing into 14 the 6 MHZ frequency band assigned to Japanese domestic television channels, an OFDM-(orthogonal frequency division multiplexing) modulated basic transmission unit called segment is formed. This segment is used for digital terrestrial television broadcasting or digital terrestrial sound broadcasting.

Signals of segment are OFDM-modulated. As the number of OFDM carriers of the segment, the three modes of 108,

216, and 432 carriers are defined. It is specified by the provisional systems that in digital terrestrial television broadcasting, a transmission signal is formed by using 13 segments, while in digital terrestrial sound broadcasting, the transmission signal is formed by using one or three segments.

The OFDM carriers within a segment are modulated by the same modulation scheme. As modulation schemes, DQPSK, QPSK, 16QAM, 64QAM, etc. are defined. In the OFDM carriers within a segment, in addition to carriers for transmitting information, there are also various pilot signals and transmission control signals. The pilot signals include CP (continual pilot) and SP (scattered pilot) signals. The transmission control signals include a TMCC (transmission and multiplexing configuration control) signal. Further, as additional information, there are AC1 (auxiliary channel 1), AC2 (auxiliary channel 2), and other signals. Among the pilot signals, CP and SP are BPSK-(binary phase shift keying) modulated by the output of PRBS (pseudo-random bit stream) code sequences corresponding to the carrier number. In addition, the additional information AC1 and AC2 at the OFDM symbol of the header of a frame, in the same way as the pilot signals CP and SP, are BPSK-modulated based on the output of the PRBS code sequences corresponding to

the carrier number. At the subsequent OFDM symbols, differential BPSK modulation is done by the additional information to be transmitted with reference to the phase of the additional information AC1 and AC2 at the OFDM symbol of the header of the frame. In the transmission control signal TMCC at the OFDM symbol of the header of a frame as well, in the same way as the additional information AC1 and AC2, are BPSK-modulated based on the output of the PRBS code sequences corresponding to the carrier number. At the subsequent OFDM symbols, differential BPSK modulation is done based on the information of the transmission control signal TMCC with reference to the phase at the OFDM symbol of the header of the frame.

In the broadband ISDB-T system, signals are formed by 13 segments. Although these segments use PRBS code sequences using the same generator polynomials, they are set to have different initial values according to segment number and are configured so that there are no conflicts in the phases of pilot signals CP at the top and end of adjacent segments. The purpose of changing the initial values for the PRBS code sequences according to the positions of segments in the above way is to randomize as much as possible the phases of the pilot signals CP and SP in the segments to prevent occurrence of peaks in

broadband ISDB-T signals and to make the signal dynamic range smaller.

Figure 5 is a view of the configuration of segments of the digital terrestrial television broadcasting system, namely, the broadband ISDB-T system, as well as the phases of the various pilot signals CP and SP, the transmission control signal TMCC, and the additional information AC1 and AC2.

As shown in this figure, in a signal of the broadband ISDB-T system, the phases of the pilot signals CP and SP, the transmission control signal TMCC, and the additional information AC1 and AC2 in each segment are randomly controlled. Therefore, occurrence of peaks in signals based on the broadband ISDB-T system can be prevented and the requirement of a dynamic range for a receiver can be relaxed.

According to the above digital terrestrial television and sound broadcasting systems, the frequency bands for broadcasting will be the frequency bands for the currently actually broadcast analog terrestrial television broadcasts. For example, it is planned to use the UHF band currently assigned to television broadcasting as the frequency band for the digital terrestrial television broadcasting and to use the VHF band currently assigned to television broadcasting as the

frequency band used for digital terrestrial sound broadcasting. Therefore, it is expected that at least the current channel configuration of the VHF band assigned to digital terrestrial sound broadcasting will not change in the course of the transition from analog television broadcasting to digital. Namely, digital terrestrial broadcasting service will be commenced also on the basis of the current television channels. From this, it is expected that signals will be configured on the basis of the 6 MHZ (4 MHZ) bandwidth in digital terrestrial sound broadcasting.

In the narrow-band ISDB-T system used in digital terrestrial sound broadcasting, 1-segment and 3-segment format signals are defined. Due to this, there is only one type of segment number in the 1-segment format and three types in the 3-segment format. Figure 6 is a view of the configuration of segments and a phase relation of various pilot signals in a narrow-band ISDB-T signal. As shown in the figure, when signals in a channel are all 1-segment signals, because all the 13 segments have the same segment number, initial values for the PRBS code sequences also become the same and phases of the pilot signals CP and SP in all 13 segments become the same as well. In addition, the transmission control signal TMCC and the additional information AC1 and AC2 when not

modulated also have equal phases in all the 13 segments. From this, when viewing the entire signals in a channel, because there are many groups of carriers having the same phases, there arises a disadvantage that the possibility of occurrence of peaks in a transmission signal is high, and it is difficult to secure the dynamic range of the front-end amplifier in a receiver.

DISCLOSURE OF THE INVENTION

The present invention was made in consideration of the above situation and has an object to provide a digital broadcasting apparatus able to suppress an increase of a dynamic range of a broadcasting signal by controlling the carrier phases of signals in digital terrestrial broadcasting in accordance with the frequencies of the transmission channels.

In order to achieve the above object, the digital broadcasting apparatus of the present invention is a digital broadcasting apparatus for generating a digital broadcasting signal based on data of source information and modulating the same to a predetermined broadcasting frequency for output, comprising a sub-signal generating circuit for generating a sub-signal for controlling signal transmission; a random sequence generating circuit for generating a pseudo-random sequence using an initial

value of a random code set based on the broadcasting frequency; a sub-signal modulating circuit for modulating the sub-signal using the pseudo-random sequence generated by the random sequence generating circuit; and a modulating circuit for performing modulation according to a predetermined modulation scheme using a main signal generated based on the data of source information and output signal of the sub-signal modulating circuit.

Alternatively, the digital broadcasting apparatus of the present invention is a digital broadcasting apparatus for generating a digital broadcasting signal based on data of source information and modulating it to a predetermined broadcasting frequency for output, comprising a frequency interleaving circuit for frequency interleaving a main signal generated according to the data of source information by using a parameter set based on the broadcasting frequency and a modulating circuit for modulating the frequency-interleaved main signal based on a predetermined modulation system.

Further, preferably, the present invention further comprises a sub-signal generating circuit for generating a sub-signal for controlling signal transmission and a sub-modulating circuit for modulating the sub-signal by using a pseudo-random sequence generated by using an initial value of a random number code set based on the

broadcasting frequency and for supplying the modulated signal to the modulating circuit.

Further, in the present invention, preferably, the modulating circuit is an OFDM modulating circuit for performing OFDM modulation using the main signal and output signal of the sub-modulating circuit, and the data of source information is sound data obtained by encoding a sound signal. The bandwidth of the broadcasting frequency is divided into a plurality of channels, a specific channel number is assigned to each channel, and the random sequence generating circuit sets an initial value of a random number code for generating a pseudo-random sequence.

According to the present invention, in the digital broadcasting apparatus, the main signal generated from sound data is frequency-interleaved according to a given parameter. Further, a pseudo-random sequence is generated according to a given initial value of a random code. Using the pseudo-random sequence, pilot signals, transmission control signals, and other sub-signals are modulated. The interleaved main signal and modulated sub-signals are modulated in accordance with a predetermined modulation scheme, for example, the OFDM modulation scheme. The modulated signal is modulated to the broadcasting frequency and emitted from an antenna.

In the present invention, either the parameter of the frequency interleaving of the main signal or the initial value of the random number code for generating a pseudo-random sequence for sub-signal modulation is controlled according to the broadcasting frequency. As a result, it is possible to keep the dynamic range of the generated broadcasting signal as small as possible. Therefore, it is possible to easily secure a dynamic range of a front-end amplification circuit in a receiver.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a circuit diagram of a first embodiment of a digital broadcasting apparatus according to the present invention.

Figure 2 is a view of the configuration of sub-channels in the ISDB-T system.

Figure 3 is a view of the correspondence between segment numbers and sub-channel numbers.

Figure 4 is a circuit diagram of a second embodiment of a digital broadcasting apparatus according to the present invention.

Figure 5 is a view of a configuration of segments and a phase relation of various pilot signals in a broadband ISDB-T signal.

Fig. 6 is a view of a configuration of segments and

a phase relation of various pilot signals in a narrow-band ISDB-T signal.

BEST MODE FOR CARRYING OUT THE INVENTION

First Embodiment

Figure 1 is a circuit diagram of a first embodiment of a digital broadcasting apparatus according to the present invention.

As shown in this figure, the digital broadcasting apparatus of the present embodiment is comprised of a broadcasting signal processing circuit 100 for processing one segment of a broadcasting signal, an inverse Fourier transform circuit 12 (IFFT), a guard interval insertion circuit 13, a quadrature modulation circuit 14, a frequency conversion circuit 15, a RF (radio frequency) signal oscillating circuit 16, a high frequency amplification circuit 17, a transmission antenna 18, and a control circuit 20.

Next, the circuits making up the digital broadcasting apparatus of the present embodiment will be explained.

The broadcasting signal processing circuit 100, as shown in this figure, is comprised of a multiplexing circuit 1, an outer coding circuit 2, an energy dispersal circuit 3, a delay adjustment circuit 4, a byte interleaving circuit 5, a convolutional coding circuit 6,